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Blockchain Technology Acceptance in Electronic Medical Record System

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ABSTRACT

Blockchain Technology is the advance information technology in medical sector that need secure data sharing among related parties in the network. The investigating factors have impacts on electronic medical record Blockchain technology adoption. Online questionnaire was developed from literature with performance expectation, trust, and risk concepts. Online survey sent to patients and medical personnel. The feedback respondents were 149. The research results showed that the most influential factor affecting the acceptance is performance expectation which includes the recognition of technological benefits and relative advantages. Trust factor has impact on acceptance and low risk has positive impact of the Blockchain technology.

Keywords: Blockchain technology, electronic medical record system, health information

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INTRODUCTION

Patient’s medical record is an important information for the process of medical treatment of patients including a personal data, personal medical profile, allergies, etc. Several hospitals adopt information communication and technology to manage patient medical records - so called Electronic Medical Record System. The patient data can be linked within the hospitals (Anderson, 2007). Moreover, doctors can diagnose symptoms precisely from the past medical treatment, and pharmacists can supply medicines correctly and accurately from the prescriptions through the system (Ricciardi et al., 2013). It is also a supporting tool for decision making. It can be used to send a warning of prohibited drugs and a message via email or applications on health information between patients and service providers to encourage patients to take care themselves in case of the absence of doctors. Besides, it can provide the information accurately and timely for strategic planning of the healthcare service providers more effectively (Blaya et al., 2010).

The current electronic medical record system is not very effective, as hospitals have used different programs. The electronic medical record systems in hospitals are private and developed to use within the organization only. Some hospitals have developed their own system, while some have purchased ready-to-use application software. It cannot be connected to other hospitals. If patients get sick while they are traveling or referred to other hospital, an access into the patients’ medical profile from their hospital could not be done. As a result, patients receive limited benefits from the data in the private electronic medical record system. Such problems make hospitals unable to transfer important information between the stakeholders in the system with confidence. Moreover, patients are not confident about the security and privacy of their data. The health service providers provide and inadequate budget for the maintenance. These issues are derived from the three key factors including completeness of data, sources and status of information and data security in sharing. It is remarkable that both correctness and completeness of the data have impact on patients’ health records.

With the advancement of Blockchain technology, it has the potential to accommodate an exchange of existing data safely. The operation of Blockchain comprises information confidential, accuracy and ready-to-use information (Linn & Koo, 2016). Those involved in this network equally have the right to receive and send the information. Blockchain has a mechanism to access into the system and information with a code for the security of the data. If there are any changes to the information, all members of the network can verify the accuracy of the information. (David & Lory, 2017) Accordingly, when the data are changed, the members of the network will know and save them; in the meantime, it helps to preserve the privacy of patients and the completeness of the data as well. The patients’ information and shared medical information recorded in the medical record system cannot be deleted or edited because it is certified by doctors or specialists who are part of the system. This is for anti-counterfeiting information, and all transactions stored in Blockchain are time stamped so the cancellation or counterfeit is complicated and difficult (Crosby et al., 2017; Eze et al., 2017). This Blockchain medical record management will allow patients to access their own medical records and control the privacy as well as ensure the security of medical records of the patient itself. It can also help to distinguish the patient's insights, so patients can be admitted by other medical centers and get continuous treatment. This can bring about trust of patients in the treatment plan and the results to be received. Participating organizations can access the patients’ information through the Application Programming Interface (API). API is a connection to exchange the data between the E-Medical Record and Blockchain to see the information related to the patient (Hoy, 2017). API works on a Smart Contract that is a protocol for transactions via computers under a condition to decrease in the need to use a trusted intermediary between the transaction partners (Krawiec et al., 2016). It can be said that Blockchain is a drive to really unlock an exchange of valuable information exchange without an intermediary to verify the information (Christidis & Devetsikiotis, 2016) since there is no any study on this subject in Thailand, this study focuses on the acceptance of adoption of
Blockchain technology in the electronic medical record system in hospitals. This study will bring about improvements of the electronic medical record system and be guidelines in providing medical services for patients in the future.

LITERATURE REVIEW

A change from a traditional format of medical records using paper to a computer software causes a critical and sustainable impact on the healthcare service system as the crucial role of the medical record system has an effect on all stakeholders in terms of privacy, security and effectiveness. In the meantime, several courts consider the law that cover a greater extent issues on privacy of the medical record system (Williams & Weber-Jahnke, 2010) In regard of relationship between doctors and patients, it changes to a patient-centered basis. Because of the rapid change and the lack of educating this new responsibility, patients have concerns about the responsibility to improve their health, and it is also found that the relationship between doctors and patients result directly in the quality of care and treatment. The development of such relations will help patients to share the personal information with their doctors in a safe and friendly environment (Chertoff, 2015). On a patient-centered basis, patients will be notified of the medical information and have more participation with the assistance of the experts to interpret the data.

Nowadays, there are many technologies available that help in recording health information for health diagnosis and treatment (Peterson et al., 2016). However, institutions are typically hesitant to share information because of privacy concerns and fears that the transmission of information may cause data leak. Even though some technologies can solve these problems, it is not worth the investment. It is necessary to have common understanding of the structure of the data for sharing information among institutions. These problems are still important obstacles. Blockchain is one of the popular technologies in many areas because it is secure and has adjustable storage to deal with privacy concerns, and share information.

For healthcare, Blockchain technology will help in cost saving and increasing productivity significantly, which are what the industry needs in order to create new values, enhance experiences in healthcare and build patient-centered health systems facilitating collaborative performance easier, safer and more effective. Canada increased its investment on E-Medical Records (EMRs) and studied about impacts of the electronic medical record system on the doctors’ performance that led to the review of the system to examine impacts of the electronic medical record system within the doctor's offices. The review found that the factors that influence the success of electronic medical record systems include the effective features of the electronic medical record system supporting the clinical application, the design of the electronic medical record system, the functions of new electronic medical records, the worth of the electronic medical record system, the expectations for the operation of the system and patient engagement (Lau et al., 2012). The review also disclosed that healthcare information is a valuable source of health information. Sharing of healthcare information is necessary to make the healthcare system operate well and to improve the quality of healthcare services. Health information is a personal asset of patients and should be owned and controlled by patients. It should not be kept widespread in various medical treatment systems to prevent data sharing and privacy.

Blockchain demonstrates a decentralized network of the public ledger, so patients are able to control and share their own information easily and securely without violating privacy. Patients who are the data owner can be assured that they control of their own health information (Yue et al., 2016). Blockchain technology helps in reducing the health information processes in the matter of working together with others and validation, data entry, and maintenance costs, and improving the accuracy of the information for security (Stagnaro, 2017). Thus, Blockchain technology solves the problem of the security and privacy of electronic health records. Patients will receive a private key that is confidentially encrypted or hashed distribution and an encoded address to unlock the information. Although the patient information will not be stored in Blockchain, it is required an authorization or essential hashes (multi-signatures or multi-sigs) to access the information with an identification and authentication to the data requested. For the service providers, they have a separate public code. When the codes of patients and service providers are used together, the verification of permission will be required to unlock the data of the patients. Patients are able to determine an access rule to unlock their medical records. In regard of an access into the system, an unauthorized access becomes very difficult for the different operating systems, so it would be impossible that the patient's information was compromised for an unauthorized access. In terms of the audit, data validation and acceptance by those involved in Blockchain will be done by accessing the hash of the data and the reference to the link history. The electronic medical records will be guaranteed for accuracy, and all medical records and documents will be signed and certified (Peter et al., 2016; Blaya et al., 2010). Currently, MedRec is the major service provider of Blockchain for medical data in many countries. MedRec has concepts to prove that the principles of decentralization and the block of the RS structure can lead to security and the electronic medical record system can work smoothly with Blockchain as well as the use of Ethereum to access the content in the storage site and the site of service providers should have the separate audit rights. Blockchain will control an access to the medical records, while patients have the rights to check the profile, treatment information, and sharing the information. This demonstrates a new method for integrating the existing systems of service providers, prioritizing API and the transparency of the network structure (Azaria et al., 2016). Blockchain technology has been employed by hospitals in countries to manage and share the electronic medical records for cancer patients. The system ensures the privacy, security, availability and control access to the data system. It reduces the duration and procedures of monitoring and sharing the medical information and supports the decision making on medical treatment as well as reduces overall costs (Dubovitskaya et al., 2017).

Conceptual Framework
The research study in the past found that perceived usefulness and relative advantage affect the performance expectancy (Wang et al., 2009; Hung et al., 2007; Brown et al., 2010). Ability, integrity and security and privacy affect the trust (Malik et al., 2016). Factor influencing Blockchain technology adoption for electronic medical record system included performance expectancy, trust and risk factors (Figure 1).

![Conceptual Framework](image)

**Figure 1: Conceptual Framework**

**METHODOLOGY**

**Research Instrument**
The consortium Blockchain type was used as a sample business model of electronic medical record Blockchain which can generate income by selling token to patients. Patients who join the electronic medical record Blockchain can allow the members in the Blockchain network to access their medical records. This study used a questionnaire as a tool of data collection. The questionnaire was developed by searching information from documents and relevant studies. The consortium Blockchain business model was explained in the introduction part of the online questionnaire which is divided into two parts. Part one is the measurement items measured by a 5-point Likert scale (5 - Strongly Agree, 1 - Strongly Disagree). The second part is personal data of respondents, such as gender, age, education, occupation, number of times to use hospital medical services (average per month), behaviors related to searching for hospital information on medical services, medical equipment used to search for the information related to hospitals providing medical services, and the knowledge about Blockchain for the electronic medical record systems.

**Selection of Respondents**
Purposive sampling was used to select target respondents who were patients, medical personnel (physicians, nurse, pharmacists, officers etc.). About 200 survey questionnaires were distributed and 149 samples responded the questionnaire, which represented about 75%.

**DATA ANALYSIS**
The measurement items of each constructs were tested to determine the reliability. Table 1 presents the Cronbach’s Alpha of measurement items which demonstrate high reliability.

Multiple regression was used to analyze the relationship of the Blockchain technology acceptance model. The results showed that perceived usefulness and relative advantage have major impact on performance expectancy (Table 2). The results showed that the ability, security and privacy and risk factors have major impacts on trust in Blockchain technology system (Table 3). Integrity has no impact. Security and privacy factor showed the highest impact on building trust in Blockchain technology. Finally, performance expectancy has the highest impact on intention to adopt the Blockchain technology for the electronic medical record system (Table 4). Perceived low risk and trust in the Blockchain technology system also have impact on acceptance.
Table 1: Composite Mean of Items and Reliability Test Result

<table>
<thead>
<tr>
<th>Construct (Item)</th>
<th>Composite Mean</th>
<th>Cronbach’s Alpha Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perceived Usefulness (4)</td>
<td>4.322</td>
<td>.823</td>
</tr>
<tr>
<td>Relative Advantage (3)</td>
<td>4.149</td>
<td>.711</td>
</tr>
<tr>
<td>Performance Expectancy (4)</td>
<td>4.352</td>
<td>.819</td>
</tr>
<tr>
<td>Ability (4)</td>
<td>4.206</td>
<td>.839</td>
</tr>
<tr>
<td>Integrity (3)</td>
<td>3.859</td>
<td>.771</td>
</tr>
<tr>
<td>Security and Privacy (5)</td>
<td>4.228</td>
<td>.812</td>
</tr>
<tr>
<td>Risk (3)</td>
<td>3.731</td>
<td>.631</td>
</tr>
<tr>
<td>Trust (4)</td>
<td>4.078</td>
<td>.630</td>
</tr>
<tr>
<td>Intention (3)</td>
<td>4.004</td>
<td>.868</td>
</tr>
</tbody>
</table>

Table 2: Regression analysis result testing the impact on performance expectancy

<table>
<thead>
<tr>
<th>Independent Factor</th>
<th>Standardized Coefficients</th>
<th>t</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perceived Usefulness</td>
<td>.476</td>
<td>6.241</td>
<td>.000**</td>
</tr>
<tr>
<td>Relative Advantage</td>
<td>.363</td>
<td>4.760</td>
<td>.000**</td>
</tr>
</tbody>
</table>

**p-value < 0.05  \ R^2 = .613

Table 3: Regression analysis result testing the impact on trust

<table>
<thead>
<tr>
<th>Independent Factor</th>
<th>Standardized Coefficients</th>
<th>t</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ability</td>
<td>.174</td>
<td>2.616</td>
<td>.010**</td>
</tr>
<tr>
<td>Integrity</td>
<td>.120</td>
<td>1.760</td>
<td>.081</td>
</tr>
<tr>
<td>Security and Privacy</td>
<td>.446</td>
<td>6.967</td>
<td>.000**</td>
</tr>
<tr>
<td>Risk</td>
<td>.237</td>
<td>3.426</td>
<td>.001**</td>
</tr>
</tbody>
</table>

**p-value < 0.05  \ R^2 = .710
Table 4: Regression analysis result testing the effect of intention to adoption Blockchain in electronic medical records

<table>
<thead>
<tr>
<th>Independent Factor</th>
<th>Standardized Coefficients</th>
<th>t</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance Expectancy</td>
<td>.363</td>
<td>4.603</td>
<td>.000**</td>
</tr>
<tr>
<td>Risk</td>
<td>.227</td>
<td>2.693</td>
<td>.008**</td>
</tr>
<tr>
<td>Trust</td>
<td>.223</td>
<td>2.400</td>
<td>.018**</td>
</tr>
</tbody>
</table>

*p-value < 0.05  \( R^2 = .503 \)

CONCLUSION

The research result showed that the most influential factor affecting to accept the Blockchain technology for the electronic medical record system is performance expectancy which includes the recognition of technological benefits and relative advantage. Perceived low risk of the Blockchain system has an impact on adoption. The trust factor has impact on electronic medical record Blockchain adoption. The results of this study can help healthcare organizations, both private and public hospitals and the Ministry of Public Health, in considering and planning to apply Blockchain technology to the hospital's electronic medical record system. The results can also lead to further development of the operating system and other relevant areas to respond to the needs of the users.

This research also asked the tendency to accept the application of Blockchain technology application for the electronic medical record system in the views of respondents who are medical personnel and used to obtain medical services at hospitals and medical personnel only. Thus, future studies should put a focus on views of information technology personnel in hospitals who are directly related to the electronic medical record system and other systems associated with the various medical information.

REFERENCES

States: ONC/NIST.


